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NOISEMAP 6.0 - THE USAF MICROCOMPUTER PROGRAM FOR AIRPORT NOISE ANALYSIS

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FOR THE COMMANDER

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13. ABSTRACT *(Maximum 200 words)*

NOISEMAP is a computer program used for generating Noise Exposure Contours in various metrics including DNL, NEF, CNEL, and WECPNL around US military bases. This program uses state-of-the-art modeling techniques developed by the Harry G. Armstrong Aerospace Medical Research Laboratory (AAMRL) to provide accurate information about noise exposure to local communities for zoning against encroachment. This model is also used by the civilian community to model noise exposure around civil and general aviation airports. Noise and performance datafiles for both US military and civil aircraft are included with the program. AAMRL recently upgraded this mainframe computer model to operate on a desktop microcomputer, resulting in tremendous time and money savings for completing any airbase noise analysis. Two additional programs, BASEOPS and NMPLOT, were created for use with this microcomputer version on NOISEMAP. BASEOPS is a computerized operations input program for creating specific cases. NMPLOT is a versatile microcomputer contouring program that takes the output of NOISEMAP and creates the resulting noise contours to the screen, to the file, or to a plotter.

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PREFACE

This report was prepared by the Biodynamic Environment Branch, Harry G. Armstrong Aerospace Medical Research Laboratory, under Project/Task 7231. The author wishes to acknowledge the support of Ms Jackie Brennaman and Ms Bea Heflin for the preparation of this report for publication and to Mr Jerry Speakman for his editorial comments.

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INTRODUCTION

Since 1971 the United States Air Force has been actively developing and improving NOISEMAP, a fully computerized procedure for generating cumulative noise exposure contours around airbases. This mainframe computer program was recently upgraded to reside on a desktop microcomputer, resulting in tremendous time and money savings for completing any airbase noise analysis. Two additional programs, BASEOPS and NMPLOT, were created for use with this microcomputer version of NOISEMAP. BASEOPS is a computerized operations input program for data entry. NMPLOT is a versatile contouring program that takes the output of NOISEMAP and creates the resulting noise contours to the screen, to a file or to a plotter. Users manuals have been published for both the new NOISEMAP and the BASEOPS programs (ref 1&2).

The underlying methodology of NOISEMAP couples an aircraft unique noise data base with a comprehensive modeling program to compute the noise exposure from aircraft flight and ground runup activity at an airbase on an average busy day. Noise source characteristics were systematically measured by the Armstrong Aerospace Medical Research Laboratory (AAMRL) for 52 military aircraft under controlled flight test conditions and 55 military aircraft under controlled ground runup test conditions . Using this data base (NOISEFILE) an additional 17 aircraft having similar engine power plants have been estimated. In addition, measured noise data are included for eleven different demountable suppressors and several aircraft/engines operating in the USAF Hush House noise suppressor. Data for 77 civil aircraft used in the US Federal Aviation Administration Integrated Noise Model are also included in NOISEFILE for use in modeling joint civil - military installations with the NOISEMAP program.

To do a noise analysis for a particular airport or airbase the user need only input the specific flight and ground runup operations via the BASEOPS program. BASEOPS is a menu driven, user friendly program that creates operations input files for the NOISEMAP program. Some of the special features of the BASEOPS program include graphic display of input ground tracks and engine power setting profiles, use of background map and navigational aids for flight track verification, default data base for civil and military aircraft power/performance/ altitude profiles, custom segmenting of profiles, on line listings of available aircraft and input flight tracks and error checking for logical data entry. Five different summary printouts are available for operations verification. BASEOPS also provides a global subset menu for creating files for

"What if" studies. This provides a simplified way to examine individual impacts from the input operations and examine noise mitigation efforts.

Once the operations inputs are created they are processed through NOISEMAP via its Master Control Module (MCM). The MCM keeps track of file input, data handling, user selected options and final data archiving. All files used with NOISEMAP are stored in standard ASCII format and can be viewed or printed directly from the MCM. Some of the special modeling features in NOISEMAP are: Excess Sound Attenuation (ESA) under ground-to-ground propagation conditions that is aircraft type and power setting dependent; lateral (sideline) attenuation of flight noise levels at low aircraft-to-observer elevation angles; takeoff roll noise model that compensates for directivity and acceleration effects; flight profile segmentation to account for variations in engine power setting and airspeed; influence of turns on predicted flight noise durations; effect of airbase (runway) altitude above sea level on thrust, airspeed and acoustic impedance; and flexibility to generate noise contour maps for any specified average temperature and relative humidity conditions.

In the NOISEMAP program two lateral attenuation models are used. For civil aircraft the lateral attenuation model developed by the Society of Automotive Engineers, Inc. A-21 Committee on Aircraft Noise (ref 3) is used. Since it was derived mainly from measured data on civil aircraft, the predicted results generally show good agreement when compared with actual measurements around airports. However the frequency spectra of most military aircraft is often quite different from that associated with civil transports, therefore AAMRL conducted a series of field experiments to collect a data base to insure the accurate prediction of the lateral attenuation associated with military aircraft flight operations. These data were analyzed and a specific algorithm was developed for military aircraft. Figure 1 shows a comparison between the military and civil aircraft lateral attenuation models.

The NOISEMAP program calculates noise exposure for a fixed grid with equal spacing of 10,000 points, calculates the area within equal noise exposure values and provides a detailed, rank ordered summary of operations and their contribution to the total noise exposure at up to twenty specific locations. This specific locations printout is useful in determining the cause of problems at a specific noise sensitive area. The MCM allows the user to input any spacing and location for the grid computations as well as determining the contour levels for the area computation calculations.

NOISEMAP can be used to generate either single event footprints or cumulative noise exposure contour maps. The noise characteristics are stored in NOISEFILE in a variety of metrics including maximum A-weighted level, perceived noise level and the time integrated A-weighted level (Sound Exposure Level) all with and without a pure tone correction. The noise data are also stored in terms of the Effective Perceived Noise Level. NOISEMAP can therefore be used to generate exposure contours in terms of the Day-Night Sound Level (DNL), Community Noise Equivalent Level (CNEL), Noise Exposure Forecast (NEF) and Weighted Equivalent Continuous Perceived Noise Level (WECPNL).

Once the noise exposure values are computed for the 10,000 grid point array, the NMPLOT program will calculate and display the user selected contours. Special features of the NMPLOT program are complete on-line context sensitive help, complete plot manipulation and annotation control (size, scaling, rotation, labeling, color, etc.), plot to screen, contour overlay, flight track display and zoom features. The program will drive any Hewlett Packard compatible plotter to produce plots to whatever size the plotter can handle. The program has the capability of plotting directly on background maps input to the plotter. Two points are identified on the map (usually a single runway end points) and fed back to the program via the plotter. With this information the program will scale and rotate the output to match the background map and plot the selected contours. Figure 2 shows the output contours from the NMPLOT program.

While rehosting the NOISEMAP program to a desktop micro-computer, AAMRL revised the code to reduce inefficiencies in the noise exposure calculations and contour generation. A typical large USAF airbase (22 different aircraft, 73 flyover profiles, 25 runup profiles) was used to determine program run times on various computers. The run times started from input of the operations files (BASEOPS output) to the grid calculation including creating the weather specific noise profiles for each aircraft type. For a 80286 based microcomputer running at 8 MHz the run time was 108 minutes. For a 80386 based microcomputer running at 20 MHz the run time was 26 minutes. To get a final contour displayed the user need only load this grid into NMPLOT, select the options (defaults are provided) for display and hit the display function key. NMPLOT takes about 2 to 3 seconds to display the contour to the screen and is limited by the plot device for paper output (typically 3 to 4 minutes).

Because NOISEMAP is a key factor in the Air Force defense against noise related lawsuits and the high cost involved in the management decisions made based on its use, several

validation studies have been conducted. Predicted single event flight noise levels were validated by hundreds of measurements and several cumulative exposure validation studies were completed showing great agreement with the NOISEMAP predicted levels (ref 4).

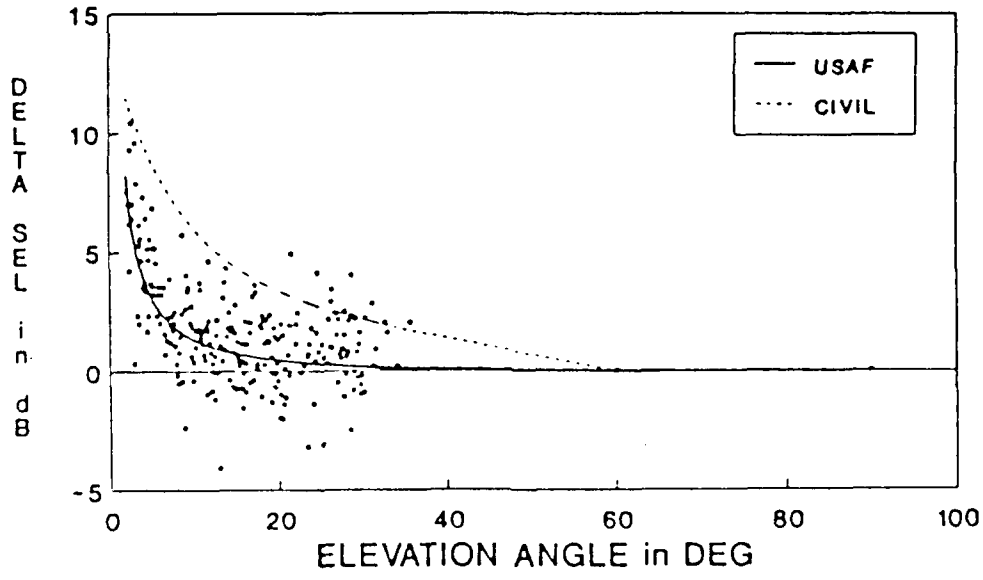

Figure 1. Lateral Attenuation Model Comparison

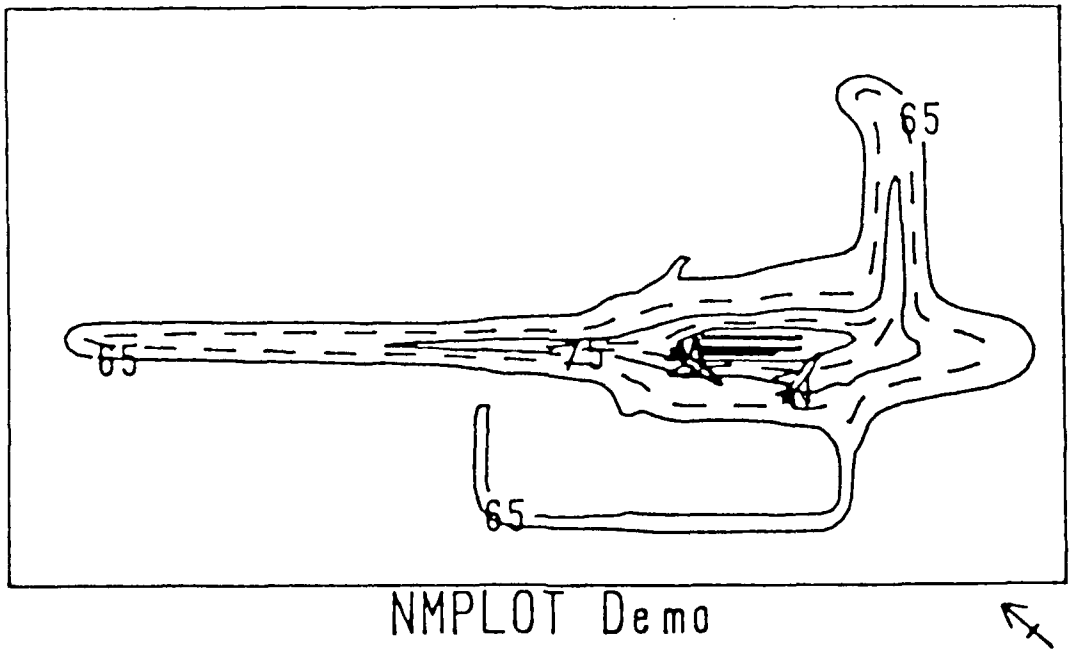

Figure 2. NOISEMAP 6.0 Plot Output

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